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ABSTRACT

This guide was developed by the United States Environmental Protection Agency (EPA) as a taxonomic reference for the identification of diatoms. The taxonomic information included consists of a generic key to the common genera of diatoms, a section illustrating 164 diatom species representing 93 common genera found at the Water Pollution Surveillance System (WPSS) stations, and an alphabetical list of the genera included in this publication. Related information includes collection and slide preparation procedures, a description of the structure of the diatom cell wall, and a glossary of terms used in diatom taxonomy. Also included is a map of the WPSS station locations in the United States and charts indicating the four most abundant diatom species at these WPSS stations. No information is given on the ecology of diatoms. (MR)

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A Guide to the Common Diatoms at Water Pollution Surveillance System Stations

U.S. ENVIRONMENTAL PROTECTION AGENCY

SE 024 836

A Guide to the Common Diatoms at Water Pollution Surveillance System Stations

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Reprint 1971

PREFACE

The taxonomic material used to prepare this guide was assembled in part by Dr. Louis G. Williams, Mr. Louis Grivetti, and Mrs. Julia Maloney, to train new employees in the Plankton Laboratory, Water Quality Section, during the early years of operation of the National Water Quality Network, developed by the U.S. Public Health Service to collect basic data on the quality of surface waters used for domestic water supplies.

The guide was first published in June, 1966, after the earlier materials were greatly expanded and revised by Dr. Cornelius I. Weber. Because of the increased interest in water quality studies in recent years, the demand for the guide has increased considerably, and is now in its fourth printing. It is currently undergoing further revision and expansion to include descriptions of the common benthic diatoms and photo- and electron micrographs.

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Introduction

A comprehensive treatise on the diatoms of the United States is yet to be published. Existing references dealing with the algae of this country are either very provincial or shallow in their coverage of the diatoms, therefore a large number of domestic and foreign publications must be consulted to find descriptions of all of our common species. This is a formidable task for the beginning diatom student. Descriptions of the diatom species which are most frequently encountered at WPSS stations have been assembled in this illustrated guide which was prepared to serve as a bench reference for biologists in our laboratory who are being trained in diatom identification. The guide also contains a glossary and generic key. The key was constructed with the beginner in mind, and is based entirely on the shape and markings of the diatom cell wall as observed in material mounted in hyrax. No attempt was made to place the taxa in their proper phylogenetic order. Laboratory personnel are encouraged to consult the taxonomic references for species identification.

We are indebted to Dr. Charles Reimer, Dr. Eugene Stoermer, and Dr. Matthew Hohn for carefully reviewing the manuscript and making many helpful suggestions. We are also grateful to the various authors and publishers who have granted permission to use selected figures from their publications.

Staff biologists who have been engaged in diatom work and have contributed to the preparation of this manual include, Carol Scott, Julia Maloney, Albert Katko, Mary Jo Sege, Louis Grivetti, Ronald Raschke, Mason Fenwick, Lydia Corrill, and Gretchen Oswald.

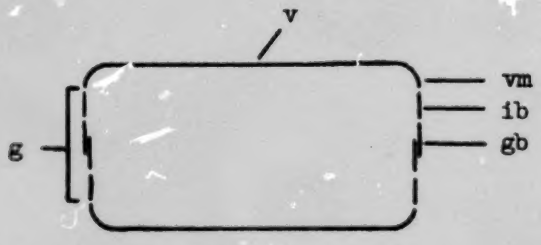
Cornelius I. Weber, Ph.D.
In Charge, Plankton Studies

Collection and Preparation of Diatom Material

The Water Pollution Surveillance System plankton samples used for diatom analyses are obtained from water plant intakes or directly from rivers or lakes at one hundred and thirty stations across the United States. The algae in the samples are concentrated by centrifuging twenty minutes at 1000 x G. Several drops of plankton concentrate are placed on a #1 coverglass, the coverglass is dried cautiously to avoid splattering, and incinerated thirty minutes on a hot plate at 1000°F. This treatment drives off most of the organic matter present, leaving only the siliceous diatom cell walls (thin-walled forms such as Rhizosolenia eriensis and Melosira crenulata may be difficult to observe). A drop of Hyrax mounting medium is placed in the center of a 75 mm x 25 mm glass slide heated to approximately 200°F. When the solvent has evaporated (the solvent-free Hyrax is hard and brittle at room temperature), the coverglass bearing the incinerated diatoms is inverted and placed on the drop of Hyrax, the slide is removed from the heat, and pressure is applied to the coverglass until the Hyrax cools and hardens (10 - 15 sec.). The finished slide is examined at 970X.

THE DIATOM CELL WALL

The diatom cell wall (frustule) is made of silica and consists of two overlapping halves, each composed of a more or less flat surface, the valve, to which are joined one or more hoop-like bands, the girdle and intercalary bands (see below).



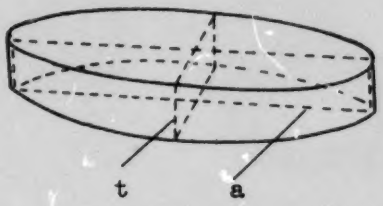
Girdle view of frustule showing valves, v; intercalary bands, ib; girdle band, gb; girdle, g; and valve mantle, vm.

The valves of the centric diatoms are generally circular in outline, with their markings arranged symmetrically about a central point; whereas, the valves of the pennate diatoms are generally elongate (linear) with their markings arranged in transverse rows along each margin.

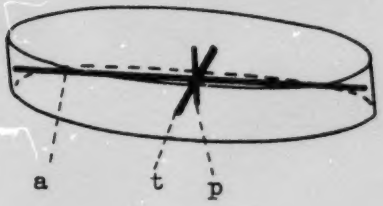
Pennate Centric

Valve views of pennate and centric diatoms showing the central area, a; raphe, r which usually occupies the medial axis of the valve; striae, s; and costae, c.

Planes and axes of symmetry are employed in keying out some of the pennate genera. They are shown in the figures below.



Oblique view of a pennate frustule showing planes; apical plane (along longitudinal or medial axis), a; transapical plane (along the transverse axis), t.



Oblique view of a pennate frustule showing axes: apical axis, a; transapical axis, t; and the pervalvar axis, p.

GLOSSARY

Arcuate - bent like a bow (see Fragilaria arcus, p. 38)

Brackish - having a dissolved salt content intermediate between fresh and salt water.

Capitate - swollen at one or both ends in valve view (see Caloneis amphisbaena, p. 63)

Carinal dots - circular or oval pores more or less evenly spaced along the keel, usually appearing as dots or lines (see Nitzschia, p. 90)

Costae - internal or external linear thickenings of the valve surface appearing as ribs; because of light diffraction, the tapered shoulders of the costae may appear as dark lines (see Cyclotella Meneghiniana, p. 26)

Facet - (alveola) a circular or hexagonal thin area in the valve surface, surrounded by a ridge which may extend internally or externally from the valve surface (see Coscinodiscus, p. 31)

Frustule - the siliceous diatom cell wall consisting of two separate halves.

Fusiform - broadest at the middle and tapering at each end, spindle-shaped (naviculoid).

Girdle - region of the frustule between the two valves.

Girdle-bands - the two overlapping hoop-like bands which join the two halves of the frustule. They may be connected directly to the valve margins or the intercalary bands.

Girdle view - side view of the frustule.

Intercalary bands - hoop-like bands located between the girdle-band and the valve (see Rhizosolenia, p. 22)

Keel - a ridge projecting from the valve-surface, enclosing the "canal" raphe, usually not medial on the valve (see Nitzschia, p. 89)

Linear - long and nearly uniform in width.

Micron - 0.001 millimeter.

Multiseriate - having more than one row of punctae (see Stephanodiscus astrea, p. 28)

Nodule - internal thickening of the cell wall in the central area or terminal portions (poles) of the valves of pennate diatoms.

Ocellus - a raised, rounded or ovate thickening of the valve surface having the appearance of a large pore (see Cyclotella ocellata, p. 27)

Poles - extreme ends of the valves of pennate diatoms.

Pseudoraphe - a smooth, linear space between the medial ends of the striae or costae on the valves of pennate diatoms. A term applied only to valves without a true raphe (see Synedra ulna, p. 45)

Punctae - small holes (pores) or thin, circular, sieve-like areas in the frustule.

Raphe - a fissure or slit in the valve face which may be along or eccentric to the medial axis of the valve; when located in a keel or wing it is referred to as a "canal" raphe.

Rhomboid - a parallelogram in which the angles are oblique and the adjacent sides are unequal (see Nitzschia, p. 89)

Septae - internal partitions or cross walls, usually appearing as dark lines (see Tabellaria fenestrata, p. 32)

Shadow-lines - dark "diffraction" lines which appear in the frustule wherever abrupt changes in thickness of the valve face occur (see Caloneis, p. 63)

Sigmoid - s-shaped (see Gyrosigma, p. 67)

Stellate - star-shaped, radiating from a point.

Striae - linear markings on the frustule which are due to closely placed punctae, or to hollow chambers in the cell wall (may sometimes appear as costae).

Sulcus - annular groove between the valve mantle and girdle (see Melosira ambigua, p. 19)

Uniseriate - having one row of punctae (see Coscinodiscus, p. 31)

Valve - the face of the diatom frustule.

Valve mantle - the part of the valve which extends below the shoulder. In the Melosiras the valve mantle is a cylindrical surface that may be 30μ long (see Melosira granulata, p. 20)

Wing - a thin projection of the valve surface, more highly developed than a keel; generally arising near the margin of the valve, but sometimes arising near the medial axis. May enclose the "canal" raphe (see Surirella, p. 87)

GENERIC KEY

1a	Valves with true raphe or pseudoraphe; ornamentation transverse and/or longitudinal.....	8
1b	Valves without true raphe or pseudoraphe; ornamentation radial about a central point.....	2
2a	Frustules usually united into long filaments..... Melosira (p. 19)	
2b	Frustules not usually united into long filaments; usually solitary but may form short chains.....	3
3a	Frustules with intercalary bands; usually seen in girdle view; one or two long spines arising from each valve....	4
3b	Frustules without intercalary bands.....	5
4a	One long spine arising from each valve..... Rhizosolenia (p. 22)	
4b	Two long spines arising from each valve....Attheya (p. 23)	
5a	Valves with two marginal protuberances or horns on opposite sides of the valve; usually seen in girdle view. Biddulphia (p. 23)	
5b	Valves lacking protuberances.....	6
6a	Valve margin with costae; ornamentation in central area different from margin..... Cyclotella (p. 24)	
6b	Valve margin otherwise; central area not sharply distinct from margin; valves with radial rows of punctae or with geometric facets.....	7

7a Punctae in multiseriate rows near valve margin, each row gradually or abruptly becoming uniseriate toward the center; marginal spines always present..... Stephanodiscus (p.28)

7b Punctae in uniseriate rows throughout, or with geometric facets..... Coscinodiscus (p. 31)

8a True raphe present on at least one valve; raphe may be very short or rudimentary, or may be concealed in a keel or wing..... 15

8b True raphe absent, pseudoraphe present on both valves... 9

9a Frustules with thick longitudinal septae running parallel to the valve faces..... Tabellaria (p.32)

9b Frustules without septae..... 10

10a Valves with thickened internal transverse ribs (costae), most of which extend completely across the valve face... 11

10b Valves without thickened internal transverse ribs..... 12

11a Valves symmetrical about the transapical plane..... Diatoma (p. 33)

11b Valves asymmetrical about the transapical plane..... Meridion (p. 36)

12a Frustules with bulbous ends, slightly concave in girdle view, typically forming stellate colonies..... Asterionella (p. 37)

12b Frustules without bulbous ends, typically not forming stellate colonies..... 13

13a Valves symmetrical about the transapical plane..... 14

13b Valves asymmetrical about transapical plane.....
Opephora (p. 38)

14a Frustules typically forming long ribbon-like chains, rarely solitary..... Fragilaria (p. 38)

14b Frustules typically solitary, sometimes forming stellate colonies; striae often appearing as costae.....
Synedra (p. 42)

15a Raphe evident on at lease one valve..... 16

15b Raphe not evident, concealed in a keel or wing..... 35

16a Valves similarly ornamented, raphe on both valves..... 19

16b Valves not similarly ornamented, raphe on one valve, opposing valve with pseudoraphe, or with rudimentary raphe near valve poles..... 17

17a Valves elliptical, never linear, sometimes bent along the apical axis..... Cocconeis (p. 47)

17b Valves not elliptical, usually linear, and usually bent along the transapical axis..... 18

18a Valves symmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with pseudoraphe..... Achnanthes (p. 50)

18b Valves asymmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with rudimentary raphe near valve poles.....
Rhoicosphenia (p. 52)

19a Raphe rudimentary, short, near poles only..... Eunotia (p. 53)

19b Raphe fully developed, extending the length of the valves..... 20

20a Valves symmetrical about both the transapical and apical plane..... 24

20b Valves asymmetrical about either the apical or transapical plane..... 21

21a Valves symmetrical about the transapical plane, asymmetrical about the apical plane..... 23

21b Valves asymmetrical about the transapical plane, symmetrical about the apical plane..... 22

22a Valve margins with longitudinal "shadow"-lines..... Gomphoneis (p. 54)

22b Valve margins lacking longitudinal shadow"-lines..... Gomphonema (p. 54)

23a Valve faces parallel..... Cymbella (p. 57)

23b Valve faces not parallel, both valves faces can be seen in girdle view..... Amphora (p. 60)

24a Valves with elongate central or terminal nodules..... 25

24b Valves without elongate central or terminal nodules..... 26

25a Central nodule drawn out to at least half the length of the valve..... Amphipleura (p. 62)

25b Central nodule drawn out less than half the length of the valve..... Frustulia (p. 62)

26a Valves with longitudinal "shadow"-lines or blank spaces..... 27

26b Valves without longitudinal lines or blank spaces..... 29

27a Transverse striae continuous, crossed by one or two longitudinal "shadow"-lines paralleling valve margin.... Caloneis (p. 63)

27b Transverse striae discontinuous, interrupted by blank spaces or "shadow"-lines..... 28

28a Longitudinal "shadow"-lines or blank spaces near valve margins; ends of raphe near central nodule usually turned in opposite directions..... Neidium (p. 64)

28b Longitudinal "shadow"-lines or blank spaces scattered, central pores of raphe near central nodule turned if at all in the same direction..... Anomoeoneis (p. 65)

29a Valves and raphe sigmoid..... 30

29b Valves and raphe not sigmoid..... 31

30a Valves with transverse and longitudinal striae..... Gyrosigma (p. 67)

30b Valves with transverse and oblique striae..... Pleurosigma (p. 67)

31a Frustules with septae..... Mastogloia (p. 68)

31b Frustules without septae..... 32

32a Raphe enclosed in a siliceous rib.....Diploneis (p. 68)

32b Raphe not enclosed in a siliceous rib..... 33

33a Valves with chambered striae appearing as heavy costae; valves usually with parallel sides and broadly rounded poles. Pinnularia (p. 70)

33b Valves with striae appearing otherwise..... 34

34a Central area extending laterally to the margins of the valve, striae absent along lateral margins of the central area..... Stauroneis (p. 70)

34b Central area not extending to the margins of the valve, striae present along lateral margins of the central area..... Navicula (p. 71)

35a Keel elevated into a lateral "wing" or flattened on the valve surface..... 37

35b Keel elevated into an axial "wing" extending along the central axis of the valve..... 36

36a Keel sigmoid, usually seen in girdle view (hour-glass-shaped), frustule twisted along the longitudinal axis; girdle broad with many longitudinal folds..... Amphiprora (p. 80)

36b Keel not sigmoid, girdle simple, not folded, keel eccentric..... Tropidoneis (p. 82)

37a Valves with numerous internal transverse ribs extending completely across the valve..... 38

37b Valves without internal transverse ribs..... 40

38a Raphe and axial area with "V"-shaped medial extension; with transverse septae appearing as costae and alternating with two or more rows of punctae..... Epithemia (p. 83)

38b Raphe and axial area without a "V"-shaped medial extension..... 39

39a Raphe canal with pores, valves symmetrical to longitudinal axis..... Denticula (p. 84)

39b Raphe canal without pores, valves asymmetrical to the longitudinal axis..... Rhopalodia (p. 84)

40a Valves with lateral keel extending along both margins of each valve..... 41

40b Valves with lateral keel extending along one margin of each valve..... 42

41a Valve face longitudinally undulate, undulations conspicuous in girdle view; with broad, short, peripheral costae; longitudinal pseudoraphe present..... Cymatopleura (p. 86)

41b Valve face not longitudinally undulate; valve face with longitudinal folds which appear as heavy costae, folds not conspicuous in girdle view; girdle view rectangular, naviculoid, wedge shaped or sigmoid; valve view linear, elliptical, ovate or spirally twisted..... Surirella (p. 87)

42a Keels eccentric to the median axis, diagonally opposite; frustules rhombic in cross section, transversely striate, punctate or lacking ornamentation; a row of circular pores ("carinal dots") developed within the keel; frustules usually solitary but occasionally forming irregular ribbon-like chains or stellate colonies.....Nitzschia (p. 89)

42b Keels eccentric to the median axis, directly opposite; frustules rectangular in cross section, transversely striate or punctate, capitate ends, medianly constructed...Hantzschia (p. 98)

Alphebetical list of Genera

Genus	Page	Genus	Page
Achnanthes	50	Gomphoneis	54
Amphipleura	62	Gomphonema	54
Amphiprora	80	Gyrosigma	67
Amphora	60	Hantzschia	[illegible]
Anomoeoneis	65	Mastogloia	63
Asterionella	37	Melosira	19
Attheya	23	Meridion	36
Biddulphia	23	Navicula	71
Caloneis	63	Neidium	64
Cocconeis	47	Nitzschia	89
Coscinodiscus	31	Opephora	38
Cyclotella	24	Pinnularia	70
Cymatopleura	86	Pleurosigma	67
Cymbella	57	Rhizosolenia	22
Denticula	84	Rhoicosphenia	52
Diatoma	33	Rhopalodia	84
Diploneis	68	Stauroneis	70
Epithemia	83	Stephanodiscus	28
Eunotia	53	Surirella	87
Fragilaria	38	Synedra	42
Frustulia	62	Tabellaria	32
		Tropidoneis	82

Illustrated Species

A total of 164 species are illustrated, representing 43 of the common genera found at the Water Pollution Surveillance System stations. Some of the species were selected primarily to demonstrate the morphological diversity within the genera. The figures have been selected from a number of publications (p. 18) and the figure credits are referred to by number immediately following the species names. The cell dimensions given are generally those from the figure source, but in some cases these have been supplemented with our own observations. The geographical distribution of 96 of the species is shown in the accompanying chart (p. 100), taken from "Plankton Population Dynamics", by L. G. Williams, PHS Pub. No. 663, Suppl. 2, 1962. Additional information regarding diatom distribution can be found in the WPSS Annual Compilations of Data, 1960-61, 1961-62, and 1962-63, PHS Pub. No. 663.

FIGURE CREDITS

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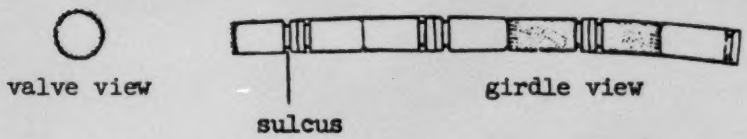
1a Valves with true raphe or pseudoraphe; ornamentation transverse and/or longitudinal 8

1b Valves without true raphe or pseudoraphe; ornamentation radial about a central point..... 2

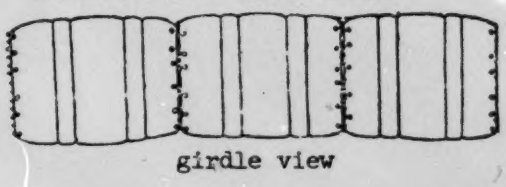
2a Frustules usually united into long filaments - MELOSIRA[1]

Fig. 1. Melosira ambigua, (3)[2], valves 4-15μ in diameter, 3-13μ long; wide, angular sulcus. X 1000. Abundant in the Ohio and Mississippi Rivers.



Notes:

Fig. 2. Melosira Binderana, (3), valves 4-25μ in diameter, 3-7μ long; in valve view may be confused with Stephanodiscus Hantzschii; has distinct pores on valve mantle (shoulder). X 1000. Common in the Great Lakes.



Notes:

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1. Valve length in Melosira is measured from the valve face to the sulcus, along the pervalvar axis (half length).

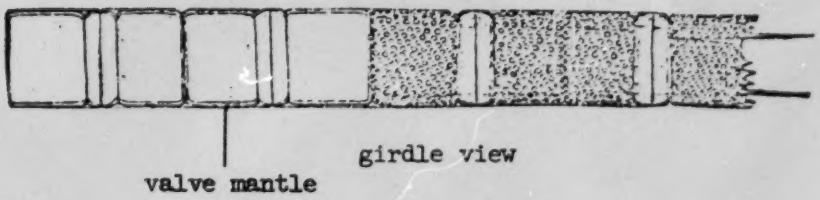
2. This number refers to the figure source.

Fig. 3. Melosira distans, (3), valves 4-20μ in diameter, 4-8μ long. X 1000. Abundant in southeastern rivers.

girdle view
var. lirata,
form lacusris

Notes:

Fig. 4. Melosira granulata, (3), valves 5-21μ in diameter, 5-18μ long; terminal cells usually with robust spines. X 1000. Common in northern U. S.



girdle view

valve mantle

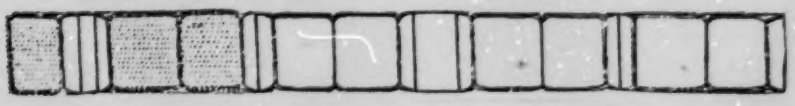
Notes:

Fig. 5. Melosira herzogii, (7), valves 4μ in diameter, 7μ long. X 2000. Found most often in southeastern U.S.

girdle view

Notes:

Fig. 6. Melosira islandica, (3), valves 7-27μ in diameter, 4-21μ long; striae on valve mantle parallel to pervalvar axis. X 1000. Common in the Great Lakes and the Columbia River.



girdle view,
subsp. helvetica

Notes:

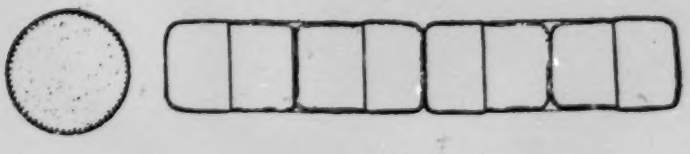
Fig. 7. Melosira italica, (3), valves 5-28μ in diameter, 8-21μ long; differentiated from M. ambigua by more robust spines and narrow sulcus. X 1000. Common in the Columbia River.

valve view

girdle view,
var. valida

Notes:

Fig. 8. Melosira varians, (3), valves 8-35μ in diameter, 9-13μ long; no visible ornamentation. X 1000. Widely distributed.



valve view

girdle view

Notes:

Notes on other species of MELOSIRA:

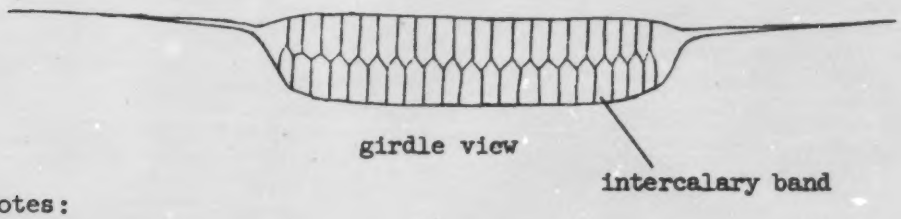
2b Frustules not usually united into long filaments; usually solitary but may form short chains..... 3

3a Frustules with intercalary bands; usually seen in girdle view; one or two long spines arising from each valve..... 4

3b Frustules without intercalary bands..... 5

4a One long spine arising from each valve - RHIZOSOLENIA

Fig. 9. Rhizosolenia eriensis, (4), cells 5-15μ in diameter, 40-150μ long; note the many intercalary bands in the girdle area. X 1000. Common in the Great Lakes.



Notes:

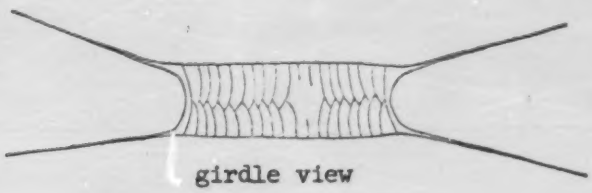
Fig. 10. Rhizosolenia minima, (4), cells 4-7μ in diameter, 15-40μ long (excluding spines). X 350. Southwestern U. S. (Red River).

girdle view

Notes:

4b Two long spines arising from each valve - ATTHEYA

Fig. 11. Attheya Zachariasi,(10), cells 12-40μ in diameter; spines 40-60μ long. X 500. In Ohio and Tennessee Rivers.

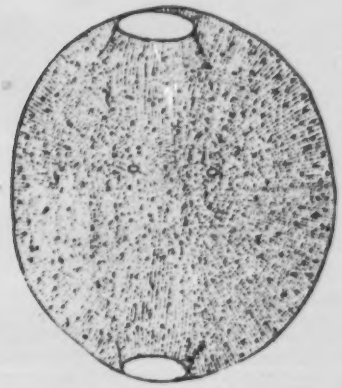


girdle view

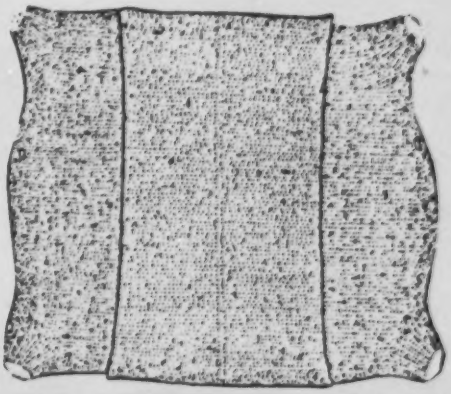
Notes:

5a Valves with two marginal protuberances or horns on opposite sides of the valve; usually seen in girdle view - BIDDULPHIA

Fig. 12. Biddulphia laevis, (10), cells 20-150μ in diameter, 50-150μ long; X 650. Southwestern U. S.



valve view



girdle view

Notes:

5b Valves lacking protuburances..... 6

6a Valve margin with costae; ornamentation in central area different from margin - CYCLOTELLA

Fig. 13. Cyclotella atomus, (3), cells 4-5μ in diameter; every 5th or 6th costae is thicker and darker than the others; single ocellus in central area. X 1500. Widely distributed.

valve view

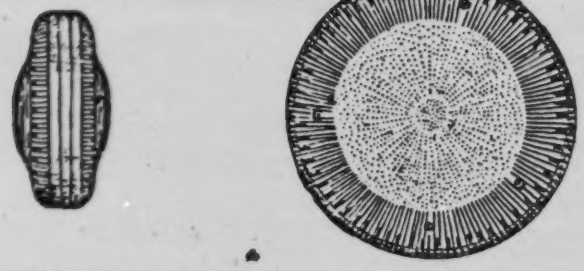
Notes:

Fig. 14. Cyclotella antiqua, (4), cells 10-30μ in diameter; wedge-shaped depressions in central area. X 1200. In Great Lakes.

valve view

Notes:

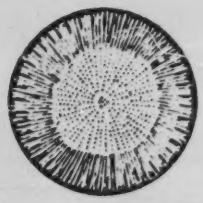
Fig. 15. Cyclotella bodanica, (4), cells 20-80μ in diameter; an isolated puncta occurs at the inner end of several shortened marginal costae. X 1000. In Great Lakes.



girdle view valve view

Notes:

Fig. 16. Cyclotella comta, (4), cells 15-20μ in diameter; similar to C. bodanica but lacking punctae at the end of shortened costae. X 1000. In Great Lakes.

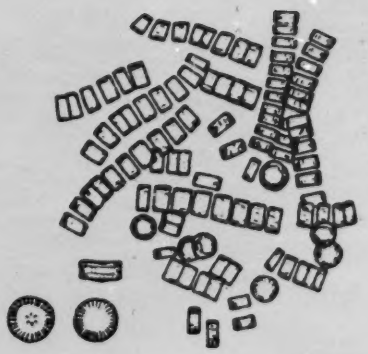


valve view

Notes:

Fig. 17. Cyclotella glomerata,(3), cells 4-10μ in diameter; forming chains; often seen in girdle view. X 1000. In Great Lakes.

Notes:



colony

Fig. 18. Cyclotella Kutzingiana, (3), cells 10-20u in diameter; center ornamentation highly variable. X 1000. Common in Great Lakes.

valve views

Notes:

Fig. 19. Cyclotella Meneghiniana, (12), cells 10-30μ in diameter; heavy marginal costae give impression of scalloped border. X 1000. Widely distributed.

valve view girdle view

Notes:

Fig. 20. Cyclotella michiganiana, (11), cells 5-20μ in diameter; valve margin with pronounced rim. X 1000.

valve views

Notes:

Fig. 21. Cyclotella ocellata, (3), cells 6-20μ in diameter; central area with 3-4 ocelli. X 1000. In Great Lakes.

valve views

Notes:

Fig. 22. Cyclotella pseudostelligera, (7), cells 7-8μ in diameter; has marginal spines. X 3000. Widely distributed.

valve view

Notes:

Fig. 23. Cyclotella stelligera, (3), cells 5-25μ in diameter. X 1000. Abundant in the southeast.

valve view

Notes:

Fig. 24. Cyclotella striata, (4), cells 10-50μ in diameter. Has a circular shadow line passing through the costae. X 1000. In Delaware and Hudson Rivers.

valve view

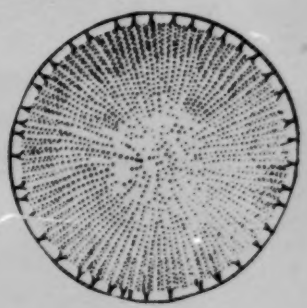
Notes:

Notes on other species of CYCLOTELLA

6b Valve margin otherwise; central area not sharply distinct from margin; valves with radial rows of punctae or with geometric facets..... 7

7a Punctae in multiseriate rows near valve margin, each row gradually or abruptly becoming uniseriate toward the center; marginal spines always present.- STEPHANODISCUS

Fig. 25. Stephanodiscus astrea (3), cells 10-30μ in diameter; spines not at end of each row of punctae. Outer punctae in double to quadruple rows, 12 punctae in 10μ. X 1000. Widely distributed.



valve view

Notes:

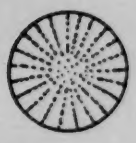
Fig. 26. Stephanodiscus dubius, (3), cells 10-25μ in diameter. X 1000. In Great Lakes and Columbia River.

valve view

girdle view

Notes:

Fig. 27. Stephanodiscus Hantzschii, (7), cells 8-20μ in diameter; 8-10 striae in 10μ; striae very light; frustule often collapses during incineration; may be confused with Melosira Binderana. X 2000. Widely distributed.



valve view

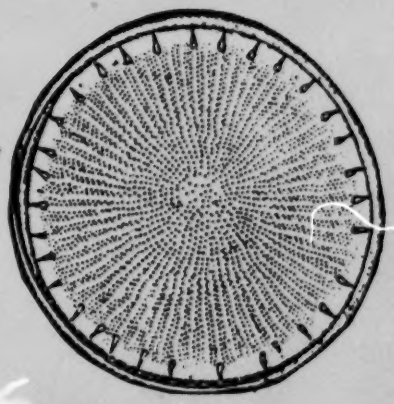
Notes:

Fig. 28. Stephanodiscus invisitatus, (7), cells 5-15μ in diameter; 15-20 striae in 10μ; striae very light; easily confused with S. Hantzschii. X 2000. Ohio River Basin.

valve view

Notes:

Fig. 29. Stephanodiscus niagarae, (3), cells 30-100μ in diameter; 3-5 rows of punctae in marginal region of striae, spines submarginal and more robust than in S. astrea. X 900. Upper Mississippi and Missouri Rivers.

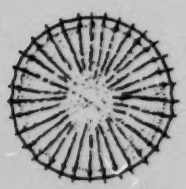


valve view

Notes:

Fig. 30. Stephanodiscus tenuis, (3), cells 8-28μ in diameter; spines at end of each row of striae. X 1000.

Notes:



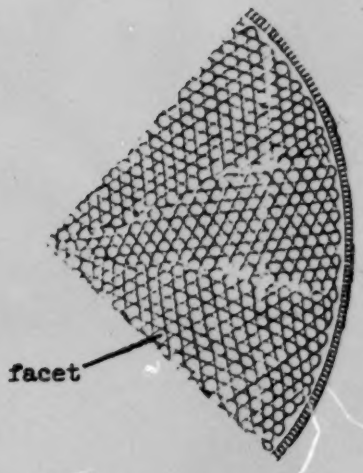
valve view

Notes on other species of STEPHANODISCUS.

7b Punctae in uniseriate rows throughout; or with geometric facets - COSCINODISCUS

Fig. 31. Coscinodiscus denarius, (4), cells 40-90μ in diameter. X 1000.

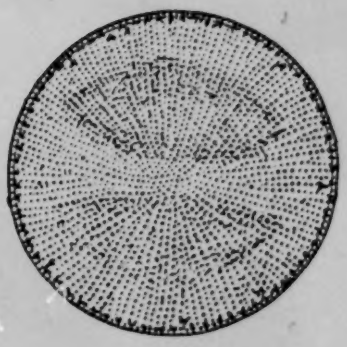
Notes:



valve view

Fig. 32. Coscinodiscus lacustris, (4), cells 20-50μ in diameter, with marginal spines. X 1000.

Notes:



valve view

Fig. 33. Coscinodiscus Rothii, (8), cells 25-40μ in diameter. X 1000. In Red and Lower Mississippi Rivers.

Notes:

valve view

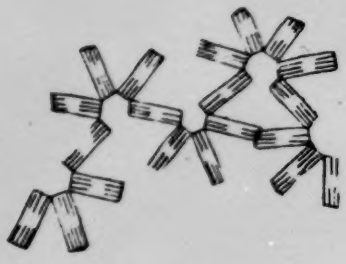
Other species of COSCINODISCUS.

8a True raphe present on at least one valve; raphe may be very short or rudimentary, or may be concealed in a keel or wing..... 15

8b True raphe absent, pseudoraphe present on both valves..... 9

9a Frustules with thick longitudinal septae running parallel to the valve face - TABELLARIA.

Fig. 34. Tabellaria fenestrata, (3), cells 30-140μ long, 3-9μ wide; 18-20 striae in 10μ;4-8 intercalary bands per cell. In Great Lakes and Columbia River.



Colony
X 250

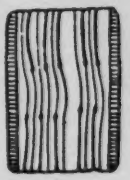
girdle view. X 1000

valve view. X 1000

Notes:

Fig. 35. Tabellaria flocculosa, (5), cells 12-50μ long, 5-16μ wide; about 18 striae in 10μ; many intercalary bands. X 1000. In Great Lakes and Columbia River.

valve view



girdle view

Notes:

9b Frustules without septae..... 10

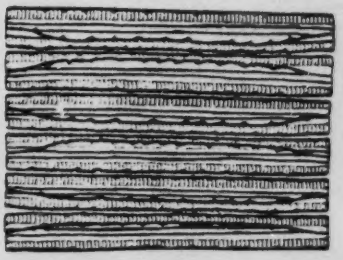
10a Valves with thickened internal transverse ribs (costae), most of which extend completely across the valve face..... 11

10b Valves without thickened internal transverse ribs..... 12

11a Valves symmetrical about the apical plane - DIATOMA

Fig. 36. Diatoma anceps, (5), cells 15-100μ long, 4-8μ wide; internal costae narrow, 3-6 in 10μ; striae delicate, 18-20 in 10μ. X 1000. In Colorado River.

valve view

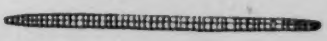


girdle view
colony

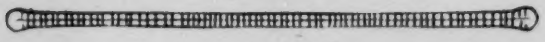
Notes:

Fig. 37. Diatoma elongatum, (5), cells 30-120μ long, 2-4μ wide; internal costae narrow, 6-10 in 10μ; striae delicate, about 16 in 10μ. X 1000. In Great Lakes and Columbia River.

girdle view



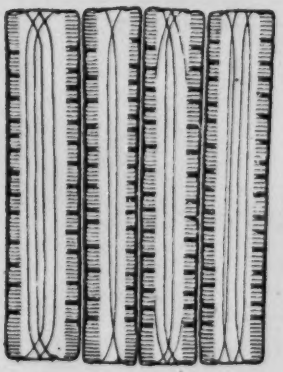
valve view of var. tenuis



valve view

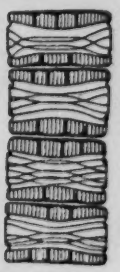
Notes:

Fig. 38. Diatoma hiemale,(4),cells 15-100μ long,7 - 20μ wide; internal costae robust, 2-4 in 10μ; striae prominent, 18-20 in 10μ. X 1000.



girdle view of part of colony

valve view



girdle view of part of colony of var. mesodon

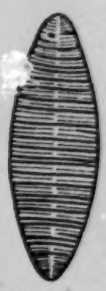
valve view of var. mesodon

Notes:

Fig. 39. Diatoma vulgare, (5), cells 30-60μ long, 10-13μ wide; internal costae narrow, 6-8 in 10μ; striae very delicate, about 18 in 10μ. Widely distributed.

Girdle view of part of colony X 500

valve view X 1000



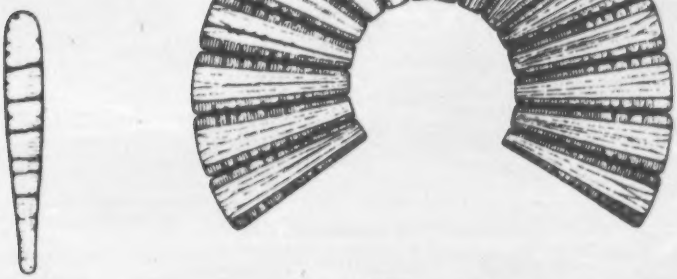
valve view, var. brevis. X 1000

Notes:

Notes on other species of DIATOMA.

11b Valves asymmetrical about the transapical plane - MERIDION

Fig. 40. Meridion circulare, (12), cells 12-80μ long, 4-8μ wide; 3-5 internal costae in 10μ; about 15 striae in 10μ. X 1000. Widely distributed.

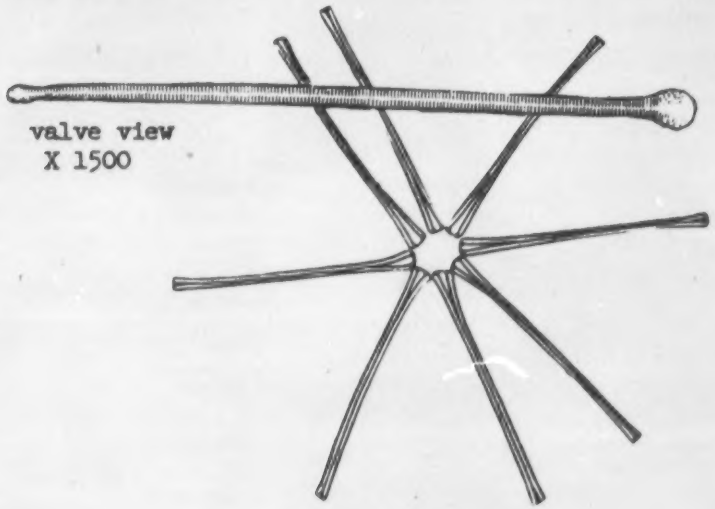


valve view girdle view

Notes:

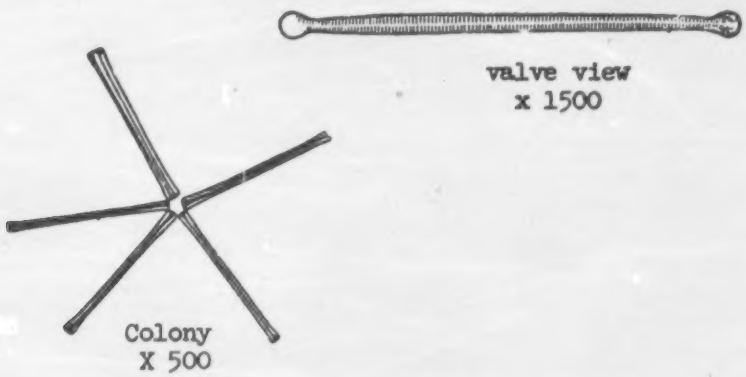
12a Frustules with bulbous ends, slightly concave in girdle view, typically forming stellate colonies - ASTERIONELLA

Fig. 41. Asterionella formosa, (3), cells 30-140μ long, 1-2μ wide; free ends inflated less than joined ends. Widely distributed.



Notes:

Fig. 42. Asterionella gracillima, (3), cells 40-130μ long, 1-2μ wide; similar to A. formosa except that the two poles of the cell are of equal size in both valve and girdle view.



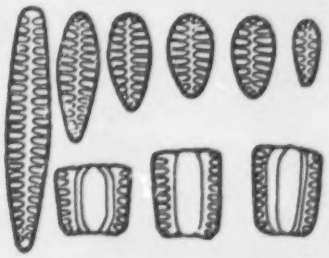
Notes:

12b Frustules without bulbous ends, typically not forming stellate colonies..... 13

13a Valves symmetrical about the transapical plane..... 14

13b Valves asymmetrical about the transapical plane - OPEPHORA

Fig. 43. Opephora Martyi, (4), cells 5-60μ long, 4-8μ wide; X 1000.



Notes:

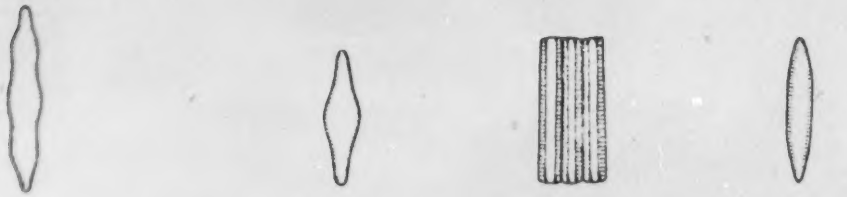
14a Frustules typically forming ribbon-like chains, rarely solitary - FRAGILARIA

Fig. 44. Fragilaria arcus, (5), cells 15-150μ long, 4-7μ wide; 15-18 striae in 10μ; cells swollen on the concave side near the central area. X 1000. Abundant in the Delaware and Columbia Rivers.

valve views

Notes:

Fig. 45. Fragilaria brevistriata, (5), cells 12-28μ long, 3-5μ wide; striae short, 13-17 in 10μ.



valve view var. trigibba X 600

valve view var. inflata X 600

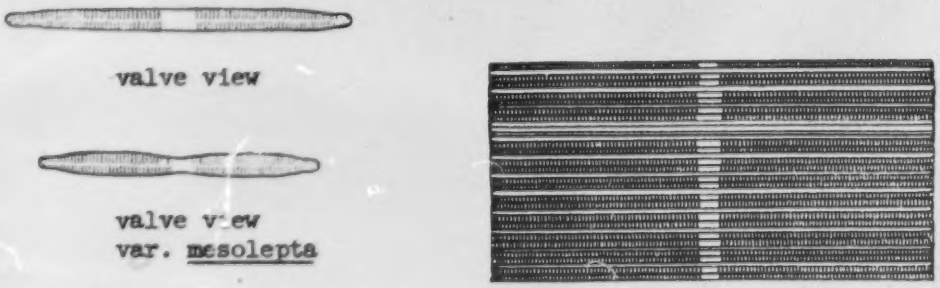
girdle view

valve view

X 1000

Notes:

Fig. 46. Fragilaria _ ucina, (3), cells 25-100μ long, 2-5μ wide; striae delicate, about 15 in 10μ; clear central area. X 1000. Abundant in northern waters.



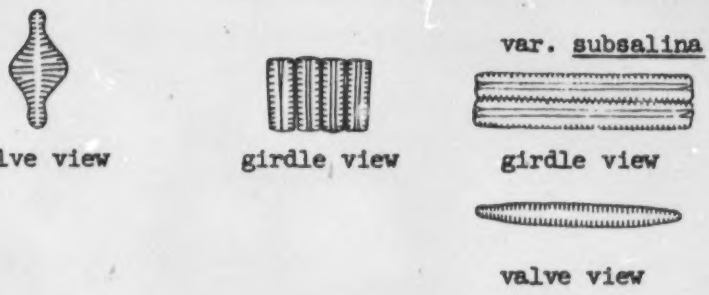
valve view

valve view var. mesolepta

girdle view

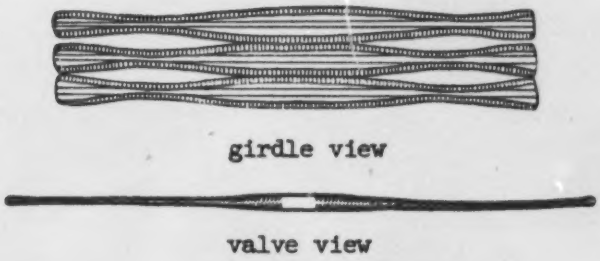
Notes:

Fig. 47. Fragilaria construens, (5), cells 7-25μ long, 5-12μ wide; striae delicate, 14-17 in 10μ; pseudoraphe broader in central region. X 1000. Abundant in northern waters.



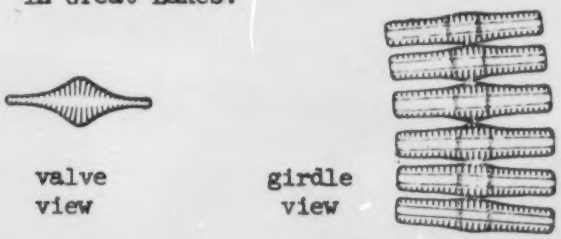
Notes:

Fig. 48. Fragilaria crotonensis, (3,5), cells 40-150μ long, 2-3μ wide; 15-18 striae in 10μ. X 1000. Widely distributed.



Notes:

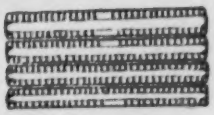
Fig. 49. Fragilaria inflata, (12), cells 18-50μ long, 6-10μ wide. X 1200. In Great Lakes.



Notes:

Fig. 50. Fragilaria intermedia, (5), cells 15-60μ long, 2-5μ wide; 9-13 striae in 10μ; central area clear on one side only. X 1000.

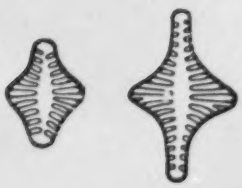
valve view



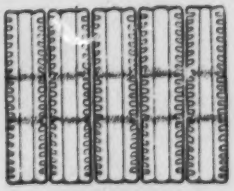
girdle view

Notes:

Fig. 51. Fragilaria leptostauron, (12), cells 13-30μ long, 10-16μ wide; striae coarse, 6-9 in 10μ. X 1000.



valve views



girdle view

Notes:

Fig. 52. Fragilaria pinnata, (5), cells 3-30μ long, 2-6μ wide; striae coarse 10-12 in 10μ. X 1000. Widely distributed.

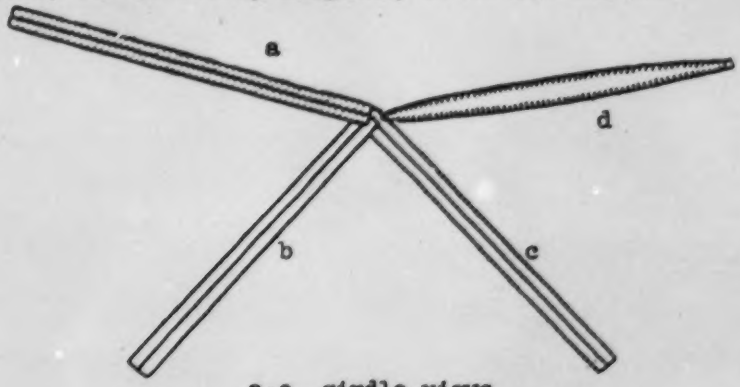
valve view

girdle view

Notes:

14b Frustules typically solitary, sometimes forming stellate colonies; striae often appearing as costae - SYNEDRA

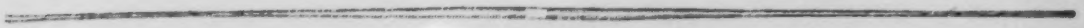
Fig. 53. Synedra actinastroides, (5), cells 35-64μ long, 2-4μ wide; striae short, marginal, 14 in 10μ. X 580.



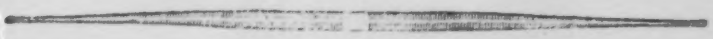
a-c, girdle views
d, valve view

Notes:

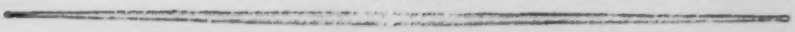
Fig. 54. Synedra acus, (5), cells 100-300μ long, 5-6μ wide; striae 12-14 in 10μ, finer than S. ulna. X 500. Widely distributed.



valve view, var. angustissima



valve view



valve view, var. radians

Notes:

Fig. 55. Synedra nana, (5), cells 50-90μ long, 1-2μ wide; striae very light, 25-30 in 10μ. X 1000. Widely distributed.

valve view

Notes:

Fig. 56. Synedra parasitica, (5), cells 10-25μ long, 3-5μ wide; striae delicate, somewhat radial, 16-19 in 10μ. X 1000. Sometimes parasitic on Nitzschia sigmoides.

Notes:

valve views

S. parasitica var. subconstricta

Fig. 57. Synedra pulchella, (5), cells 33-150μ long, 5-8μ wide; about 12-15 striae in 10μ (sometimes as many as 20); large clear refractive central area. X 1000.

valve views

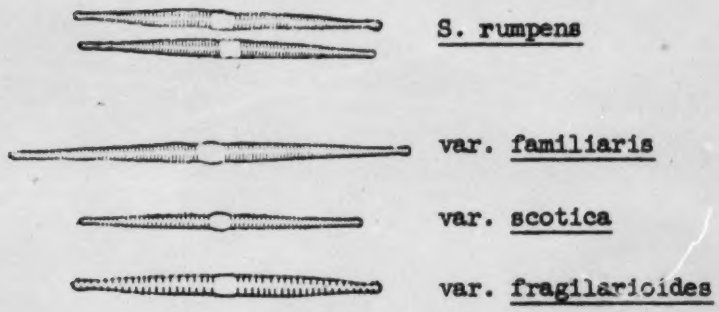
S. pulchella

var. lanceolata form constricta | var. minuta | var. naviculacea

Notes:

Fig. 58. Synedra rumpens, (5), cells 15-70μ long, 2-3μ wide; 19-20 striae in 10μ; central area variable or completely absent. X 1000.

valve views



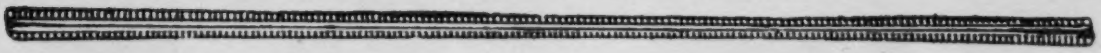
Notes:

Fig. 59. Synedra tabulata, (5), cells 60-150μ long, 2-5μ wide; striae short, 10-14 in 10μ. May form chains. X 1000.

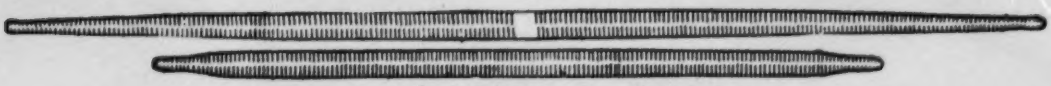
valve views

Notes:

Fig. 60. Synedra ulna, (5), cells 50-350μ long, 5-9μ wide; striae delicate, distinctly punctate, 8 - 12 (usually about 10) in 10μ; highly variable. X 600. Widely distributed.

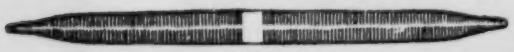


girdle view, S. ulna



valve views, S. ulna

valve views



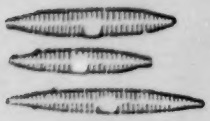
var. oxyrhynchus

var. oxyrhynchus, form contracta

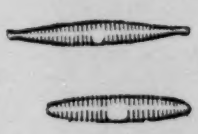
var. impressa

Notes:

Fig. 61. Synedra Vaucheriae, (5), cells 10-40μ long, 2-4μ wide; 12-16 striae in 10μ; central area clear and thickened only on one side. X 1000. Widely distributed.



valve views,
S. Vaucheriae



var. capitellata

var. truncata

valve views

Notes:

Notes on other species of SYNEDRA.

15a Raphe evident on at least one valve..... 16

15b Raphe not evident, concealed in a keel or wing..... 35

16a Valves similarly ornamented, raphe on both valves..... 19

16b Valves not similarly ornamented, raphe on one valve, opposing valve with pseudoraphe, or with rudimentary raphe near valve poles..... 17

17a Valves elliptical, never linear, sometimes bent along the apical axis - COCCONEIS

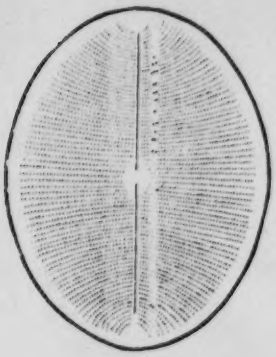
Fig. 62. Cocconeis diminuta, (5), cells 7-15μ long, 5-9μ wide, flat; rapheless valve with 32 delicate striae in 10μ; raphe-bearing valve with 13 coarsely punctate striae in 10μ. X 1000.

valve with raphe

valve without raphe

Notes:

Fig. 63. Cocconeis pediculus, (5), cells 15-56μ long, 10-37μ wide, strongly bent along the apical axis; valve with raphe has 16-18 distinctly punctate striae in 10μ; rapheless valve with 15-17 striae in 10μ, which are crossed by several widely-spaced, undulating, longitudinal rows of coarse punctae. X 1000. Widely distributed.



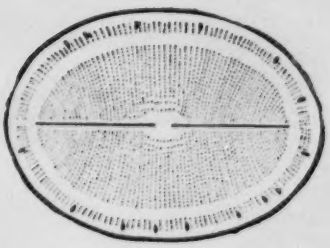
raphe-bearing valve

rapheless valve

section through transapical plane; raphe-bearing valve in ventral position.

Notes:

Fig. 64. Cocconeis placentula, (5), cells 11-70μ long, 8-40μ wide, flat or only slightly curved; raphe-bearing valve with about 23 striae in 10μ, rapheless valve with about 25 striae in 10μ. X 1000. Widely distributed.

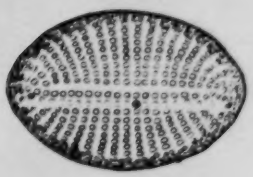


raphe-bearing valve

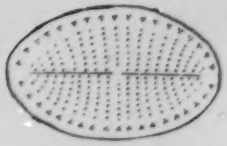
rapheless valve

Notes:

Fig. 65. Cocconeis scutellum, (5), cells 20-60μ long, 12-40μ wide, flat. Raphe less valve with coarsely punctate striae. X 1000.



Rapheless valve



raphe-bearing valve

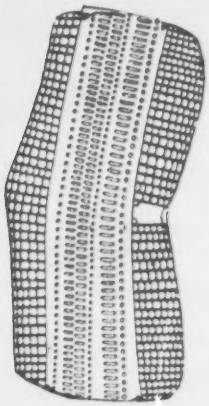
Notes:

Notes of other species of COCCONEIS.

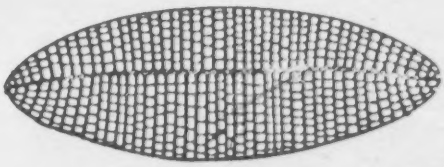
17b Valves not elliptical, usually linear, and usually bent along the transapical axis..... 18

18a Valves symmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with pseudoraphe - ACHNANTHES

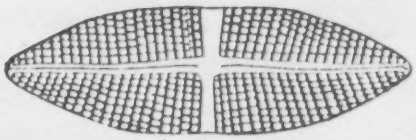
Fig. 66. Achnanthes brevipes, (5), cells 20-125μ long, 12-30μ wide; coarsely punctate. X 1000.



girdle view



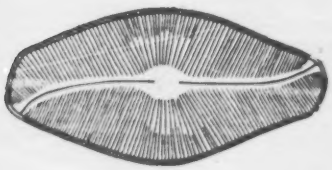
rapheless valve



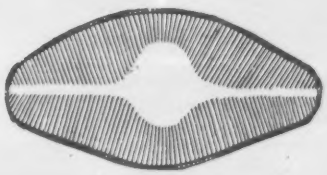
raphe-bearing valve

Notes:

Fig. 67. Achnanthes flexella, (11), cells 20-80μ long, 10-26μ wide; sigmoid raphe. X 1500.



raphe-bearing valve



rapheless valve

Notes:

Fig. 68. Achnanthes inflata, (5), cells 30-65μ long, 10-18μ wide. X 1000.

raphe-bearing valve rapheless valve

Notes:

Fig. 69. Achnanthes lanceolata, (5), cells 5-40μ long, 4-10μ wide; striae prominent, 13-17 in 10μ; central area of rapheless valve with horseshoe-shaped spot. X 1500. Common in Great Lakes.

raphe-bearing valve rapheless valve rapheless valve of var. rostrata

Notes:

Fig. 70. Achnanthes minutissima, (5), cells 5-40μ long, 2-4μ wide; striae delicate, about 35 in 10μ. Curved girdle view very common. X 1500. Widely distributed.

raphe-bearing valve rapheless valve girdle view

Notes:

Notes on other species of ACHNANTHES.

18b Valves asymmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with rudimentary raphe near valve poles - RHOICOSPHENIA

Fig. 71. Rhoicosphenia curvata, (5), cells 12-75μ long, 4-8μ wide; curved and wedge-shaped in girdle view; 12-15 striae in 10μ. X 1000. Widely distributed.

valve views girdle view

Notes:

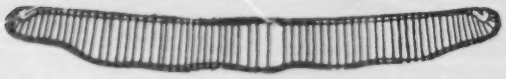
19a Raphe rudimentary, short, near poles only - EUNOTIA.

Fig. 72. Eunotia pectinalis, (5), cells 40-140μ long, 5-10μ wide; arcuate in valve view, rectangular in girdle view; 7-12 striae in 10μ. X 1000. Common in soft waters.

valve views

E. pectinalis

var. ventralis

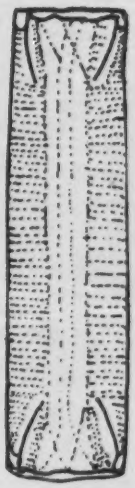


var. undulata

var. minor

var. minor
form impressa

girdle view
E. pectinalis



Notes:

19b Raphe fully developed, extending the length of the valves..... 20

20a Valves symmetrical about both the transapical and apical plane..... 24

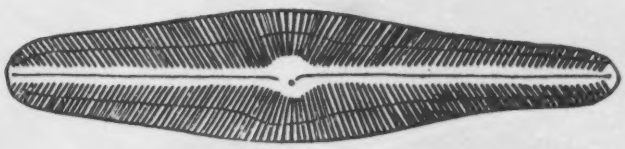
20b Valves asymmetrical about either the apical or transapical plane..... 21

21a Valves symmetrical about the transapical plane, asymmetrical about the apical plane..... 23

21b Valves asymmetrical about the transapical plane, symmetrical about the apical plane..... 22

22a Valve margins with longitudinal "shadow"-lines - GOMPHONEIS

Fig. 73. Gomphoneis herculeana, (11), cells 30-136μ long, 12-22μ wide; 9-12 striae in 10μ; central area rounded with an isolated puncta. X 1000.

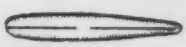


valve view

Notes:

22b Valve margins lacking longitudinal "shadow"-lines - GOMPHONEMA

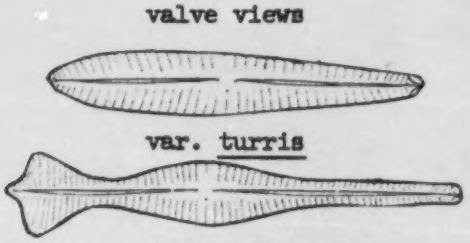
Fig. 74. Gomphonema abbreviatum, (5), cells 7-34μ long, 2-6μ wide; 19-22 striae in 10μ. X 1000.



valve view

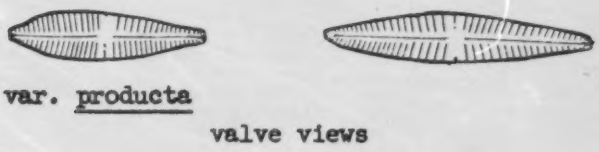
Notes:

Fig. 75. Gomphonema acuminatum, (5), cells 20-70μ long, 5-11μ wide; 10-13 striae in 10μ; one isolated puncta in the central area. X 1000.



Notes:

Fig. 76. Gomphonema angustatum, (5), cells 10-45μ long, 5-9μ wide; 9-14 striae in 10μ; one isolated puncta in the central area; easy to confuse with G. parvulum. X 1000.



Notes:

Fig. 77. Gomphonema constrictum, (5), cells 25-65μ long, 8-14μ wide; 10-12 striae in 10μ; one isolated puncta in the central area. X 1000.

Notes:

Fig. 78. Gomphonema olivaceum, (12), cells 10-40μ long, 5-10μ wide; 10-14 striae in 10μ; no isolated punctae in the central area. X 1000. Widely distributed.

valve views girdle view

Notes:

Fig. 79. Gomphonema parvulum, (5), cells 8-30μ long, 4-7μ wide; 14-16 striae in 10μ; one isolated puncta in the central area. X 1000.

valve views

var. subelliptica var. micropus

Notes:

Notes on other species of GOMPHONEMA.

23a Valve faces parallel - CYMBELLA

Fig. 80. Cymbella affinis, (5), cells 20-70μ long, 7-16μ wide; 9-12 striae in 10μ; ventral median striae ending in an isolated prominent puncta. X 1000.

valve views

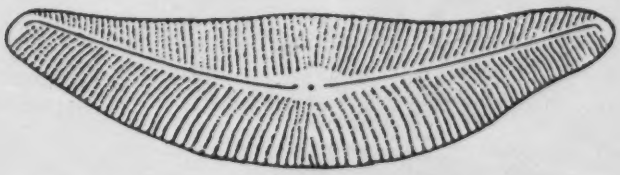
Notes:

Fig. 81. Cymbella cistula, (5), cells 35-180μ long, 15-36μ wide; 6-9 striae in 10μ; two or more prominant punctae in the central area. X 1000.

valve view

Notes:

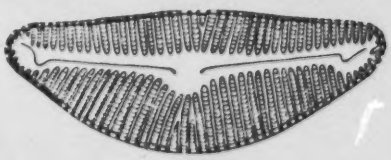
Fig. 82. Cymbella mexicanum, (1), cells 50-100μ long, 20-40μ wide; central area with a prominant puncta; similar to C. tumida, but striae have coarser punctae. X 800.



valve view

Notes:

Fig. 83. Cymbella prostrata, (5), cells 20-100μ long, 10-30μ wide; 7-10 striae in 10μ. X 1000.



valve view

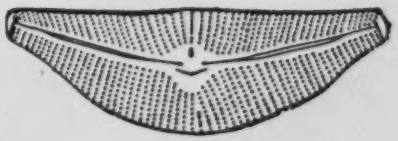
Notes:

Fig. 84. Cymbella sinuata, (5), cells 10-40μ long, 4-9μ wide; 9-11 striae in 10μ; do not confuse with Achnanthes sp. X 1000.

valve view

Notes:

Fig. 85. Cymbella tumida, (5), cells 40-105μ long, 15-23μ wide; 8-10 striae in 10μ; central area with a ventrally placed isolated puncta. X 1000.



valve view

Notes:

Fig. 86. Cymbella turgida, (5), cells 30-100 μ long, 9-25μ wide; 7-9 striae in 10μ; similar to C. ventricosa, but larger and with more conspicuous punctae. X 1000.

valve view

Notes:

Fig. 87. Cymbella ventricosa, (5), cells 10-40μ long, 5-12μ wide; 12-18 striae in 10μ; raphe straight. X 1000.

valve views

Notes:

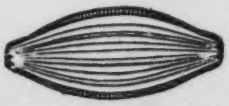
Notes on other species of CYMBELLA.

23b Valve faces not parallel, both valve faces can be seen in girdle view - AMPHORA

A diagrammatic polar view of Amphora, (7).

Fig. 88. Amphora coffeaeformis, (5), cells 20-50μ long, 10-18μ wide; 16-25 striae in 10μ; intercalary bands fine, about 21 in 10μ. X 1000.

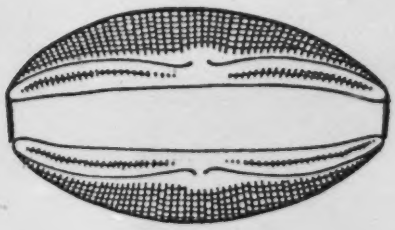
valve view



girdle view

Notes:

Fig. 89. Amphora ovalis, (5), cells 20-140μ long, 17-63μ wide; 10-13 striae in 10μ. X 1000.



girdle view

Notes:

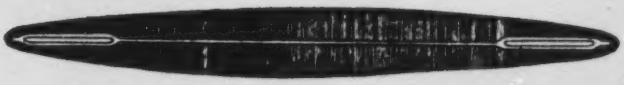
Notes on other species of AMPHORA.

24a Valves with elongate central or terminal nodules..... 25

24b Valves without elongate central or terminal nodules..... 26

25a Central nodule drawn out to at least half the length of the valve - AMPHIPLEURA

Fig. 90. Amphipleura pellucida, (8), cells 50-140μ long, 7-9μ wide; punctae delicate and difficult to see. X 1000.

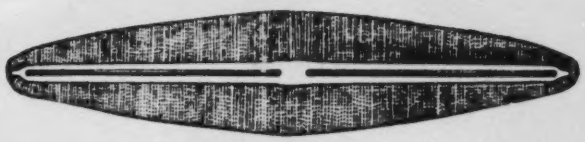


valve view

Notes:

25b Central nodule drawn out less than half the length of the valve - FRUSTULIA

Fig. 91. Frustulia rhomboides, (8), cells 50-160μ long, 20-30μ wide. X 1000.



valve view

Notes:

Fig. 92. Frustulia vulgaris, (5), cells 30-70μ long, 10-13μ wide. X 1000.

valve view
var. capitata

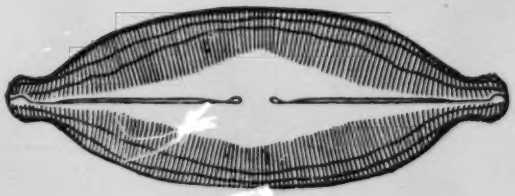
Notes:

26a Valves with longitudinal "shadow"-lines or blank spaces..... 27

26b Valves without longitudinal lines or blank spaces..... 29

27a Transverse striae continuous, crossed by one or two longitudinal "shadow"-lines paralleling valve margin - CALONEIS

Fig. 93. Caloneis amphisbaena, (5), cells 36-80μ long, 20-30μ wide. X 1000. Common in the Rio Grande River.



valve view

Notes:

Fig. 94. Caloneis bacillum, (5), cells 15-45μ long, 4-9μ wide; can be mistaken for Stauroneis sp. X 1000.

valve view

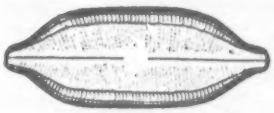
Notes:

Notes on other species of CALONEIS.

27b Transverse striae discontinuous, interrupted by blank spaces or "shadow"-lines..... 28

28a Longitudinal "shadow"-lines or blank spaces near valve margins; ends of raphe near central nodule usually turned in opposite directions - NEIDIUM

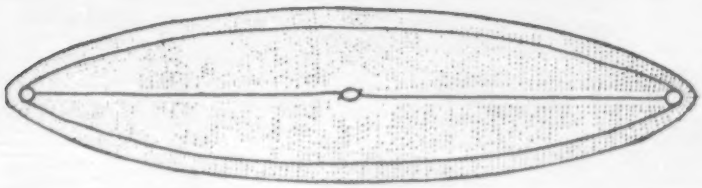
Fig. 95. Neidium dubium, (11), cells 30-46μ long, 10-16μ wide. X 1000.



valve view

Notes:

Fig. 96. Neidium iridis, (11), cells 60-100μ long, 23-24μ wide. X 1000.



valve view
var. firma

Notes:

Notes on other species of NEIDIUM .

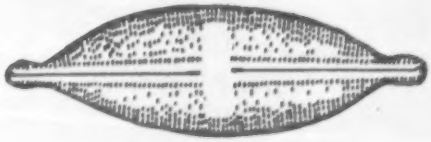
28b Longitudinal "shadow"-lines or blank spaces scattered, central pores of raphe near central nodule turned if at all in the same direction - ANOMOEONEIS

Fig. 97. Anomoeoneis exilis, (11), cells 10-35μ long, 4-6μ wide. X 1000. Abundant in the southern Colorado River.

valve view

Notes:

Fig. 98. Anomoeoneis sphaerophora, (8), cells 40-80μ long, 13-20μ wide. X 1000.



valve view

Notes:

Notes on other species of ANOMOEONEIS

29a Valve and raphe sigmoid..... 30

29b Valves and raphe not sigmoid..... 31

30a Valves with transverse and longitudinal striae - GYROSIGMA

Fig. 99. Gyrosigma Kutzingii, (5), cells 60-120μ long, 5-15μ wide. X 1000.

valve view

Notes:

Fig. 100. Gyrosigma scalproides, (5), cells 25-70μ long, 5-10μ wide. X 1000.

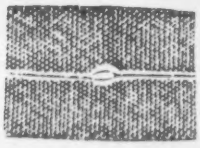
valve view

Notes:

30b Valves with transverse and oblique striae - PLEUROSIGMA

Fig. 101. Pleurosigma delicatulum, (10), cells 60-100μ long, 10-15μ wide.

valve view
X495

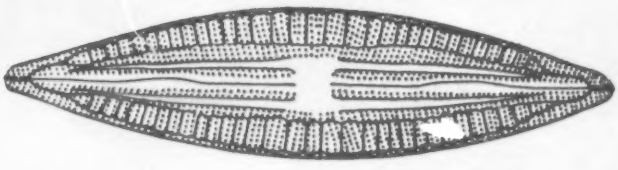


valve view
X1300

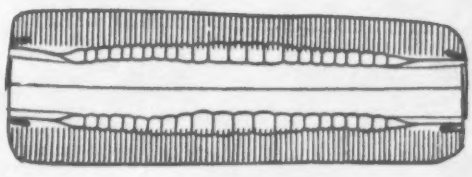
Notes:

31a Frustules with septae - MASTOGLOIA

Fig. 102. Mastogloia Braunii, (5), cells 35-95μ long, 14-27μ wide. X 1000.



valve view



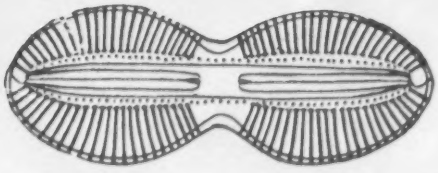
girdle view

Notes:

31b Frustules without septae..... 32

32a Raphe enclosed in a siliceous rib - DIPLONEIS

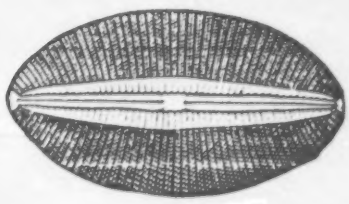
Fig. 103. Diploneis interrupta, (5), cells 30-80μ long, 7-15μ wide. X 1000.



valve view

Notes:

Fig. 104. Diploneis Smithii, (5), cells 8-20μ long, 5-10μ wide. X 1000. Abundant in the southwest.



valve view

Notes:

Notes on other species of DIPLONEIS.

32b Raphe not enclosed in a siliceous rib..... 33

33a Valves with chambered striae appearing as heavy costae; valves usually with parallel sides and broadly rounded poles - PINNULARIA

Fig. 105. Pinnularia borealis, (5), cells 20-110μ long, 8-18μ wide; 4-6 striae in 10μ. X 1000.

valve view

Notes:

Fig. 106. Pinnularia gibba, (5), cells 50-140μ long, 7-18μ wide; wide axial area and broad capitate ends. X 1000.

valve view

Notes:

33b Valves with striae appearing otherwise..... 34

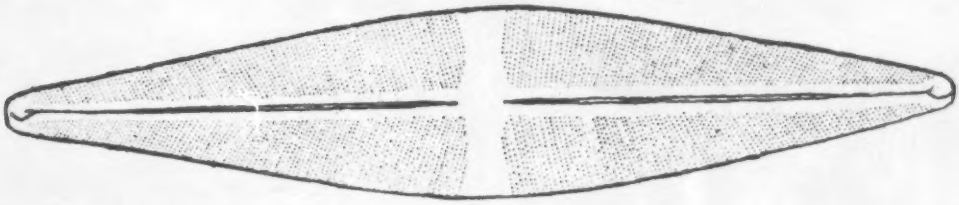
34a Central area extending laterally to the margins of the valve, striae absent along lateral margins of the central area - STAURONEIS

Fig. 107. Stauroneis crucicula, (1), cells 30-34μ long, 8-12μ wide; striae parallel to the branches of the stauros, 24 in 10μ. X 800.

valve view

Notes:

Fig. 108. Stauroneis phoenicentron, (11). cells 70-325μ long, 16-53μ wide; striae distinctly punctate, 12-20 in 10μ. X 1000.



valve view

Notes:

34b Central area not extending to the margins of the valve, striae present along lateral margins of the central area - NAVICULA

Fig. 109. Navicula bacillum, (5), cells 20-80μ long, 10-20μ wide; central area rounded not quadrangular; middle striae, 12-14 in 10μ, 18-20 striae in 10μ near the poles; do not mistake for N. pupula. X 1000.

valve view

Notes:

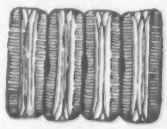
Fig. 110. Navicula canalis, (2), cells 10-27μ long, 3-5μ wide; 16-18 striae in 10μ. X 1000.

valve view

Notes:

Fig. 111. Navicula confervacea, (4), cells 10-28μ long, 5-8μ wide; 18-22 striae in 10μ; may be found in chains like Fragilaria; raphe can be seen in girdle view. X 1000.

valve views



girdle view

Notes:

Fig. 112. Navicula contenta, (5), cells 5-15μ long, 2-3μ wide. X 1500. May reach high numbers in southeastern brackish-water stations.

valve views

N. contenta form parallela form biceps

Notes:

Fig. 113. Navicula cryptocephala, (5), cells 20-40μ long, 5-7μ wide; striae fine, 16-18 in 10μ. X 1000.

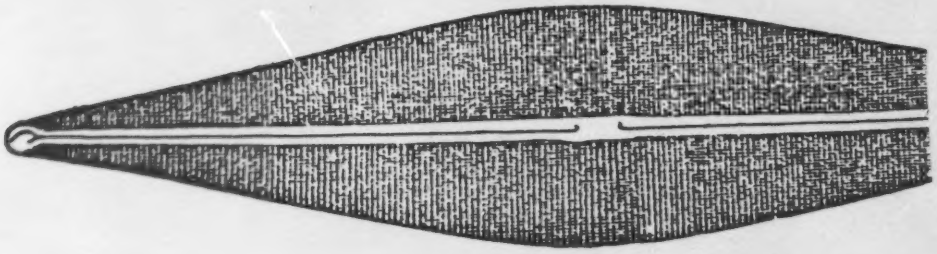
valve views

N. cryptocephala var. veneta var. intermedia

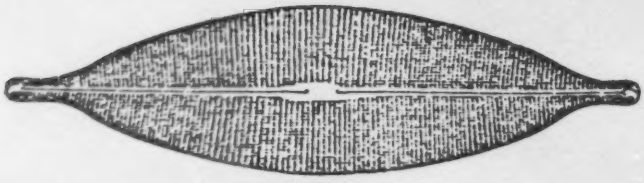
Notes:

Fig. 114. Navicula cuspidata, (5), cells 50-170μ long, 17-37μ wide; striae fine, 11-19 in 10μ. X 1000.

valve views



N. cuspidata



var. ambigua

var. Heribaudi

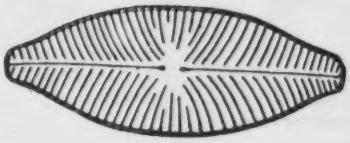
Notes:

Fig. 115. Navicula exigua, (5), cells 10-35μ long, 7-15μ wide; 12-14 striae in 10μ. X 1000.

valve view

Notes:

Fig. 116. Navicula gastrum, (5), 25-60μ long, 12-20μ wide; 8-10 striae in 10μ. X 1000.



valve view

Notes:

Fig. 117. Navicula hungarica, (5), cells 10-30μ long, 4-7μ wide; 8-10 striae in 10μ. X 1000. Abundant in the southwest.

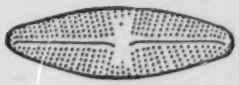
valve views

N. hungarica

var. capitata

Notes:

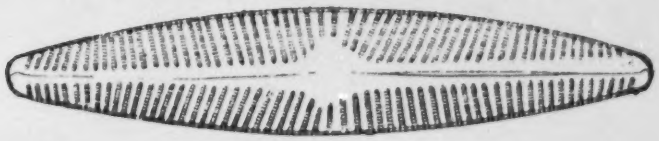
Fig. 118. Navicula mutica, (5), cells 10-40μ long, 7-12μ wide; 15-20 striae in 10μ; single eccentric puncta in the central area. X 1500.



valve view

Notes:

Fig. 119. Navicula peregrina, (5), cells 50-150μ long, 10-30μ wide; 5-6 striae in 10μ. X 1000.



valve view

Notes:

Fig. 120. Navicula pupula, (5), cells 20-40μ long, 7-10μ wide; 22-26 striae in 10μ; no striae at the poles; central area quadrangular; can mistake for N. bacillum. X 1000.

valve view
var. capitata

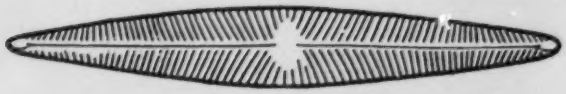
Notes:

Fig. 121. Navicula pygmaea, (5), cells 10-45μ long, 8-24μ wide; about 26 striae in 10μ. X 1000.

valve view

Notes:

Fig. 122. Navicula radiosa, (5), cells 40-120μ long, 8-20μ wide; 10-12 striae in 10μ. X 1000.



valve view

Notes:

Fig. 123. Navicula Reinhardtii, (5), cells 35-70μ long, 14-20μ wide; 7-9 striae in 10μ. X 1000.

valve view

Notes:

Fig. 124. Navicula tripunctata, (5), cells 35-60μ long, 6-10μ wide; 11-12 striae in 10μ; central area quadrangular. X 1000.

valve view

Notes:

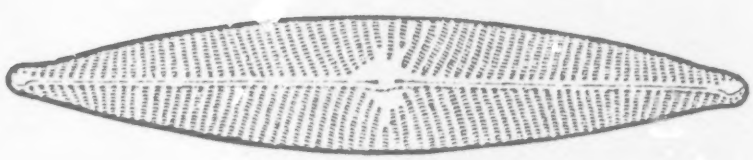
Fig. 125. Navicula viridula, (5), cells 36-80μ long, 10-15μ wide; 10 striae in 10μ; central area rounded. X 1000.

valve view

Notes:

Fig. 126. Navicula Zanoni, (6), cells 27-60μ long, 7-11μ wide; 13-14 striae in 10μ; can be confused with N. cryptocephala.

valve view
X 1000



valve view
X 2000

Notes:

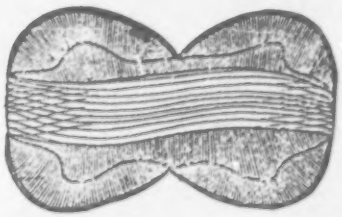
Notes on other species of NAVICULA.

35a Keel elevated into a lateral "wing" or flattened on the valve surface 37

35b Keel elevated into an axial "wing" extending along the central axis of the valve..... 36

36a Keel sigmoid, usually seen in girdle view (hour-glass-shaped), frustule twisted along the longitudinal axis; girdle broad with many longitudinal folds - AMPHIPRORA

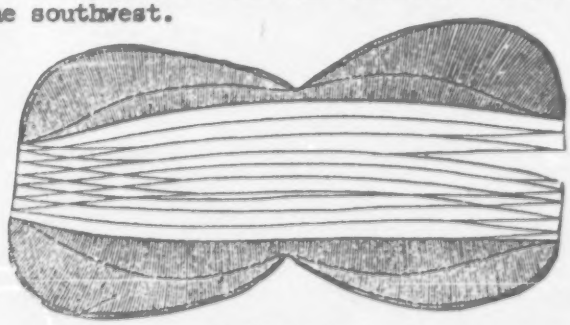
Fig. 127. Amphiprora alata, (5), cells 40-160μ long, 20-60μ wide; striae fine, punctae discernable. X 1000. Abundant in the southwest.



girdle view

Notes:

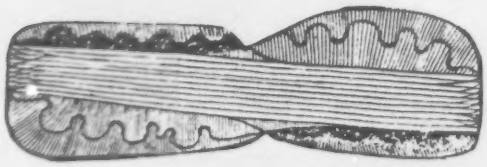
Fig. 128. Amphiprora paludosa, (5), cells 30-130μ long, 15-50μ wide; striae fine, punctae not discernable. X 1000. Abundant in the southwest.



girdle view

Notes:

Fig. 129. Amphiprora ornata, (5), cells 35-115μ long, 15-40μ wide; appears to be twisted in girdle view. X 1000.



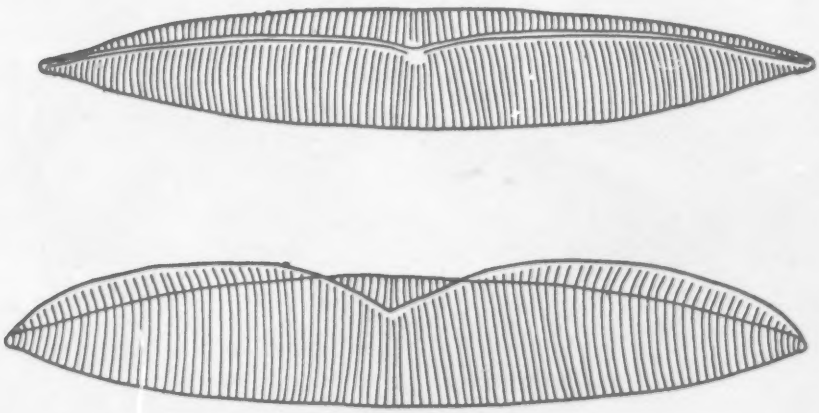
girdle view

Notes:

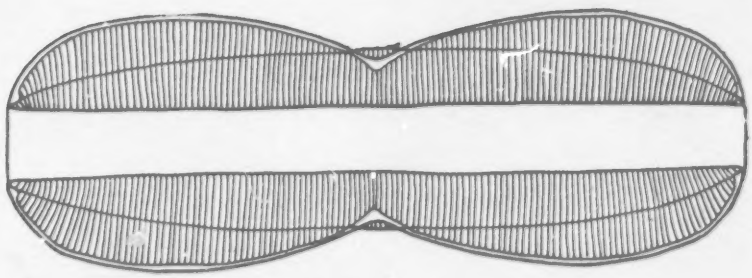
Notes on other species of AMPHIPRORA

36b Keel not sigmoid, girdle simple, not folded, keel eccentric - TROPIDONEIS

Fig. 130. Tropidoneis lepidoptera, (9), cells 40-100μ long, 10-15μ wide; girdle view easily confused with Amphiprora sp. X 2000.



valve views



girdle view

Notes:

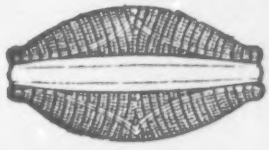
37a Valves with numerous internal transverse ribs extending completely across the valve..... 38

37b Valves without internal transverse ribs..... 40

38a Raphe and axial area with "V"-shaped medial extension; with transverse septae appearing as costae and alternating with two or more rows of punctae - EPITHEMIA

Fig. 131. Epithemia sorex, (12), cells 20-65μ long, 8-15μ wide; 5-7 septae in 10μ; 12-15 punctae rows in 10μ. X 1000.

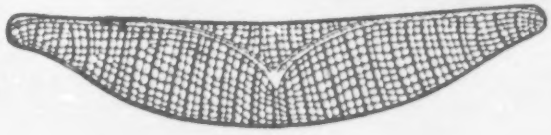
valve view



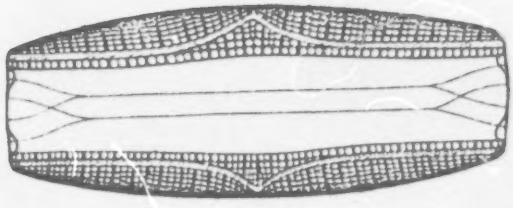
girdle view

Notes:

Fig. 132. Epithemia turgida, (12), cells 60-220μ long, 15-18μ wide; 3-5 septae in 10μ, 7-9 punctate rows in 10μ. X 1000.



valve view



girdle view

Notes:

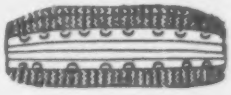
Notes on other species of EPITHEMIA.

38b Raphe and axial area without a "V"-shaped medial extension..... 39

39a Raphe canal with pores, valves symmetrical to longitudinal axis - DENTICULA

Fig. 133. Denticula elegans, (5), cells 15-40μ long, 5-7μ wide; 3-5 transverse ribs in 10μ; 15-17 striae in 10μ.

valve view

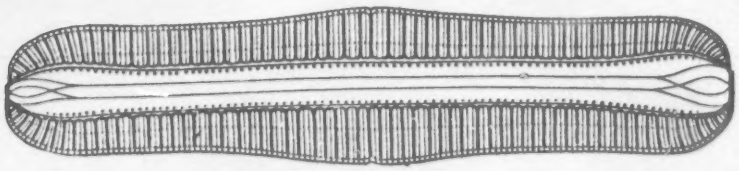


girdle view

Notes:

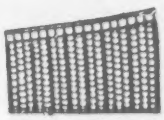
39b Raphe canal without pores, valves asymmetrical to the longitudinal axis - RHOPALODIA

Fig. 134. Rhopalodia gibba, (12), cells 35-300μ long, 6-30μ wide; 6-8 costae in 10μ; 12-16 punctate rows in 10μ.



girdle view
X 1200

valve view
X 750

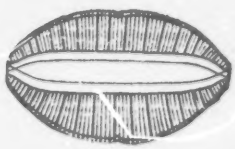


section of valve
X 2000

Notes:

Fig. 135. Rhopalodia gibberula, (5), cells 25-80μ long, 12-40μ wide; 3-4 ventral costae in 10μ, 14-17 punctate rows in 10μ. X 1000.

valve view
var. van Heurckii



girdle view

Notes:

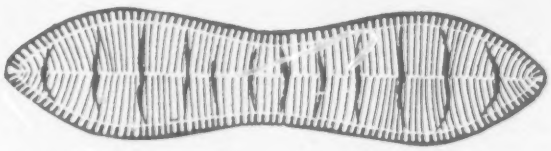
Notes on other species of RHOPALODIA.

40a Valves with lateral keel extending along both margins of each valve..... 41

40b Valves with lateral keel extending along one margin of each valve..... 42

41a Valve face longitudinally undulate, undulations conspicuous in girdle view; with broad, short, peripheral costae; longitudinal pseudoraphe present - CYMATOPLEURA

Fig. 136. Cymatopleura solea, (5), cells 30-300μ long, 12-40μ wide. X 750.

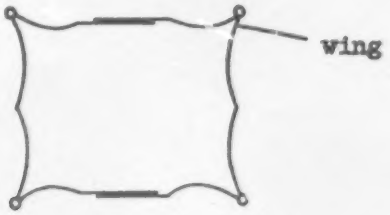


valve view

girdle view

Notes:

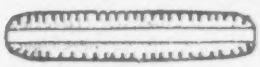
41b Valve face not longitudinally undulate; valve face with longitudinal folds which appear as heavy costae, folds not conspicuous in girdle view; girdle view rectangular, naviculoid, wedge-shaped, or sigmoid; valve view linear, elliptical, ovate, or spirally twisted - SURIRELLA



Diagrammatic cross-section
of Surirella, (7)

Fig. 137. Surirella angustata, (5), cells 18-70μ long, 6-20μ wide; 6-9 longitudinal folds in 10μ; striae delicate, the only "common" Surirella that is transversely symmetrical. X 1000.

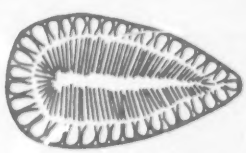
valve view



girdle view

Notes:

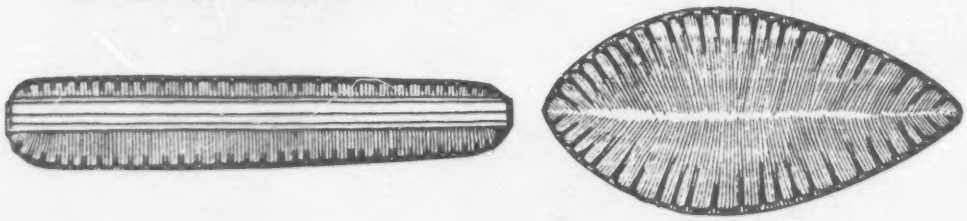
Fig. 138. Surirella brightwellii, (7), cells 30-50μ long, 15-30μ wide; longitudinal folds not extended to the center; border raised. X 1000. In Arkansas and Colorado Rivers.



valve view

Notes:

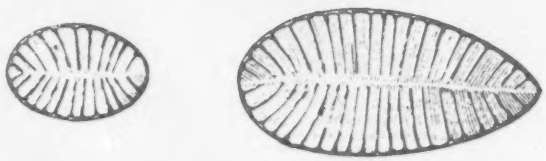
Fig. 139. Surirella ovalis, (5), cells 20-100μ long, 10-40μ wide; 1.5-5 longitudinal folds in 10μ; striae distinct, about 16 in 10μ. X 1000.



valve view girdle view

Notes:

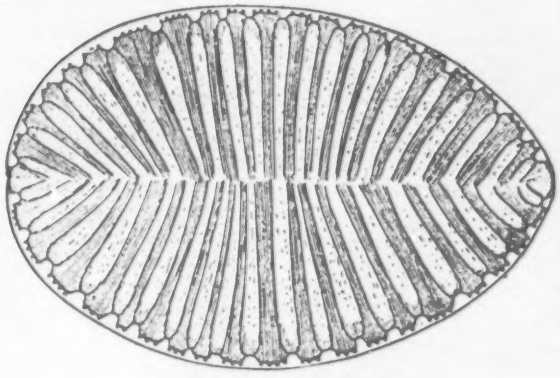
Fig. 140. Surirella ovata, (5), cells 10-70μ long, 8-23μ wide; longitudinal folds extend to the center, 4-7 in 10μ; striae fine but distinct, 16-20 in 10μ. X 1000. Common in the southwest.



valve views

Notes:

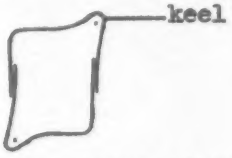
Fig. 141. Surirella striatula, (5), cells 80-260μ long, 50-160μ wide; longitudinal folds very wide, 0.6-1.2 in 10μ; small distinct protruberances on the outer edge of the longitudinal folds. X 400.



valve view

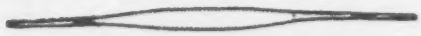
Notes:

42a Keels eccentric to the median axis, diagonally opposite;frustules rhombic in cross section, transversely striate, punctate or lacking ornamentation; a row of circular pores ("carinal dots") developed within the keel; frustules usually solitary but occasionally forming irregular ribbon-like chains or stellate colonies - NITZSCHIA



Diagrammatic cross-section of Nitzschia, (7).

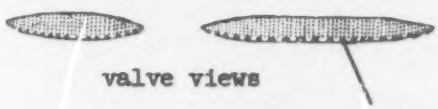
Fig. 142. Nitzschia acicularis, (5), cells 40-150μ long, 3-4μ wide; carinal dots small, 17-20 in 10μ; frustule delicate. X 1000.



valve view

Notes:

Fig. 143. Nitzschia amphibia, (5), cells 12-50μ long, 3-5μ wide; 7-9 carinal dots in 10μ; striae with distinct punctae, 15-19 in 10μ. X 1000.



valve views

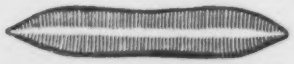
Notes:

Fig. 144. Nitzschia angustata, (5), cells 20-110μ long, 5-10μ wide; carinal dots indistinct; 12-18 striae in 10μ. X 1000.

valve view

Notes:

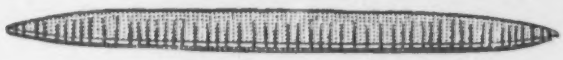
Fig. 145. Nitzschia apiculata, (5), cells 20-50μ long, 5-8μ wide; differs from N. hungarica by having indistinct carinal dots; about 17-20 striae in 10μ. X 1000. Common in the Arkansas River.



valve view

Notes:

Fig. 146. Nitzschia denticula, (5), cells 10-100μ long, 3-8μ wide; carinal dots rib-like and extended, 5-8 in 10μ; 14-20 striae in 10μ. X 1000. In southwest.



valve view

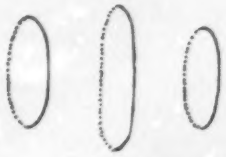
Notes:

Fig. 147. Nitzschia dissipata, (5), cells 15-70μ long, 4-7μ wide; keel slightly eccentric, 6-8 carinal dots in 10μ; striae indistinct. X 1000.

valve view

Notes:

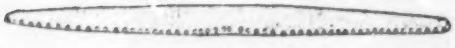
Fig. 148. Nitzschia elliptica, (6), cells 13-22μ long, 5-6μ wide; carinal dots small, 16-20 in 10μ; striae indistinct; frustule delicate. X 1000. At times abundant in the Arkansas River.



valve view

Notes:

Fig. 149. Nitzschia filiformis, (5), cells 20-100μ long, 4-6μ wide; 8-11 carinal dots in 10μ; about 36 striae in 10μ. X 1000.



valve view

girdle view

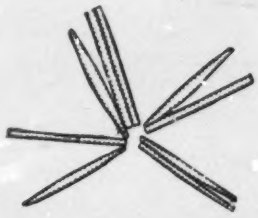
Notes:

Fig. 150. Nitzschia fonticola, (5), cells 11-30μ long, 2-4μ wide; 12-15 carinal dots in 10μ; striae fine, but distinct, 28-30 in 10μ. X 1000. In the Snake River.

valve view

Notes:

Fig. 151. Nitzschia holsatica, (5), cells 20-55μ long, 1.5-2μ wide; 14-17 carinal dots in 10μ; striae fine; indistinguishable from other forms unless in the stellate colony. X 1000. Common in the southwest.



Colony

Notes:

Fig. 152. Nitzschia hungarica, (5), cells 20-110 μ long, 6-9μ wide; carinal dots distinct, 7-9 in 10μ; 16-20 striae in 10μ. X 1000. Abundant in the southwest.

valve view

Notes:

Fig. 153. Nitzschia lacunarum, (5), cells 65-75μ long, 6-8μ wide; carinal dots small, 7-8 in 10μ; about 30 striae in 10μ. X 1000.

valve view

Notes

Fig. 154. Nitzschia linearis, (5), cells 70-180μ long, 5-6μ wide; 8-13 carinal dots in 10μ; striae fine, 28-30 in 10μ. X 1000. Common.

valve view

girdle view

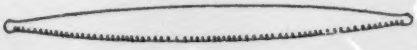
Notes:

Fig. 155. Nitzschia Lorenziana, (5), cells 65-160μ long, 3-5μ wide; 6-8 carinal dots in 10μ; striae distinct, 17-19 in 10μ. X 1000.

valve view

Notes:

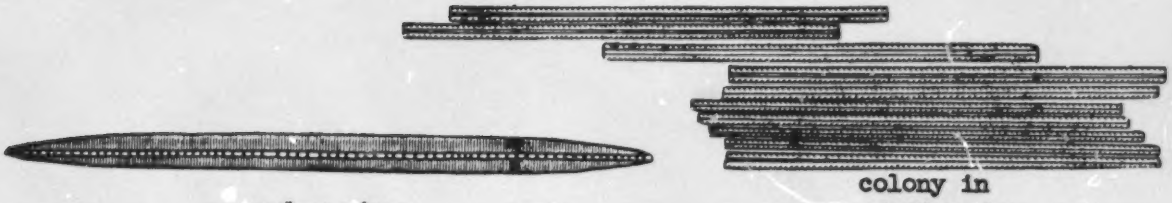
Fig. 156. Nitzschia palea, (12),20-65μ long, 2-5μ wide; 10-15 carinal dots in 10μ; striae very fine, 35-40 in 10μ. X 1000. Widespread.



valve view

Notes:

Fig. 157. Nitzschia paradoxa, (5), cells 60-100μ long, 4-6μ wide; 6-8 carinal dots in 10μ; 20-25 striae in 10μ; do not confuse with N. dissipata.



valve view
X 1000

colony in
girdle view
X 500

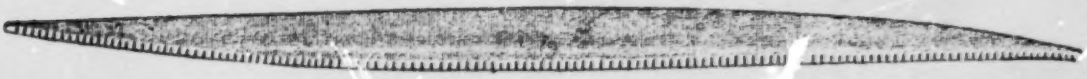
Notes:

Fig. 158. Nitzschia parvula, (5), cells 20-40μ long, 3-6μ wide; 5-8 carinal dots in 10μ; striae fine, 30-35 in 10μ. X 1000.

valve view

Notes:

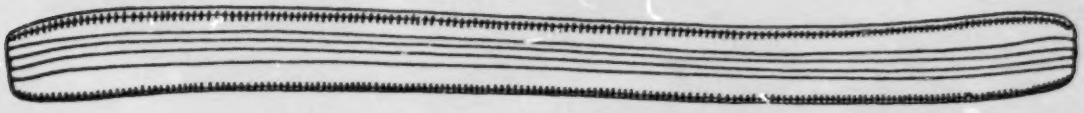
Fig. 159. Nitzschia sigma, (5), cells 50-70μ long, 4-5μ wide; 7-12 carinal dots in 10μ; 22-30 striae in 10μ. X 1000.



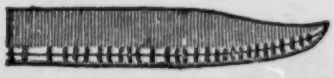
valve view

Notes:

Fig. 160. Nitzschia sigmoidea, (3), cells 160-500μ long, 8-14μ wide; 5-7 carinal dots in 10μ; striae distinct, 23-26 in 10μ.



girdle view
X 500



valve view
X 1000

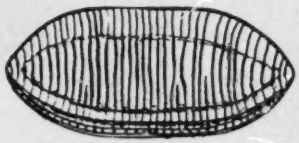
Notes:

Fig. 161. Nitzschia sinuata, (5), cells 20-50μ long, 5-8μ wide; 5-6 carinal dots in 10μ; about 18 striae in 10μ. X 1000.

valve views

Notes:

Fig. 162. Nitzschia tryblionella, (5), cells 30-100μ long, 15-26μ wide; about 6 carinal dots in 10μ; 5-7 ribs in 10μ. X 1000.



valve view
var. victoriae

Notes:

Notes on other species of NITZSCHIA

42b Keels eccentric to the median axis, directly opposite; frustules rectangular in cross section, transversely striate or punctate, capitate ends, medianly constructed - HANTZSCHIA

Diagrammatic cross-section of Hantzschia, (7)

Fig. 163. Hantzschia amphioxys, (5), cells 20-100μ long, 5-10μ wide; carinal dots not elongate, 5-8 in 10μ; 13-20 striae in 10μ. X 1000. In the southwest.

valve view

Notes:

Fig. 164. Hantzschia virgata, (5), cells 20-150μ long, 6-12μ wide; carinal dots elongate, 4-6 in 10μ; 9-15 striae in 10μ. X 1000.

valve view

Notes:

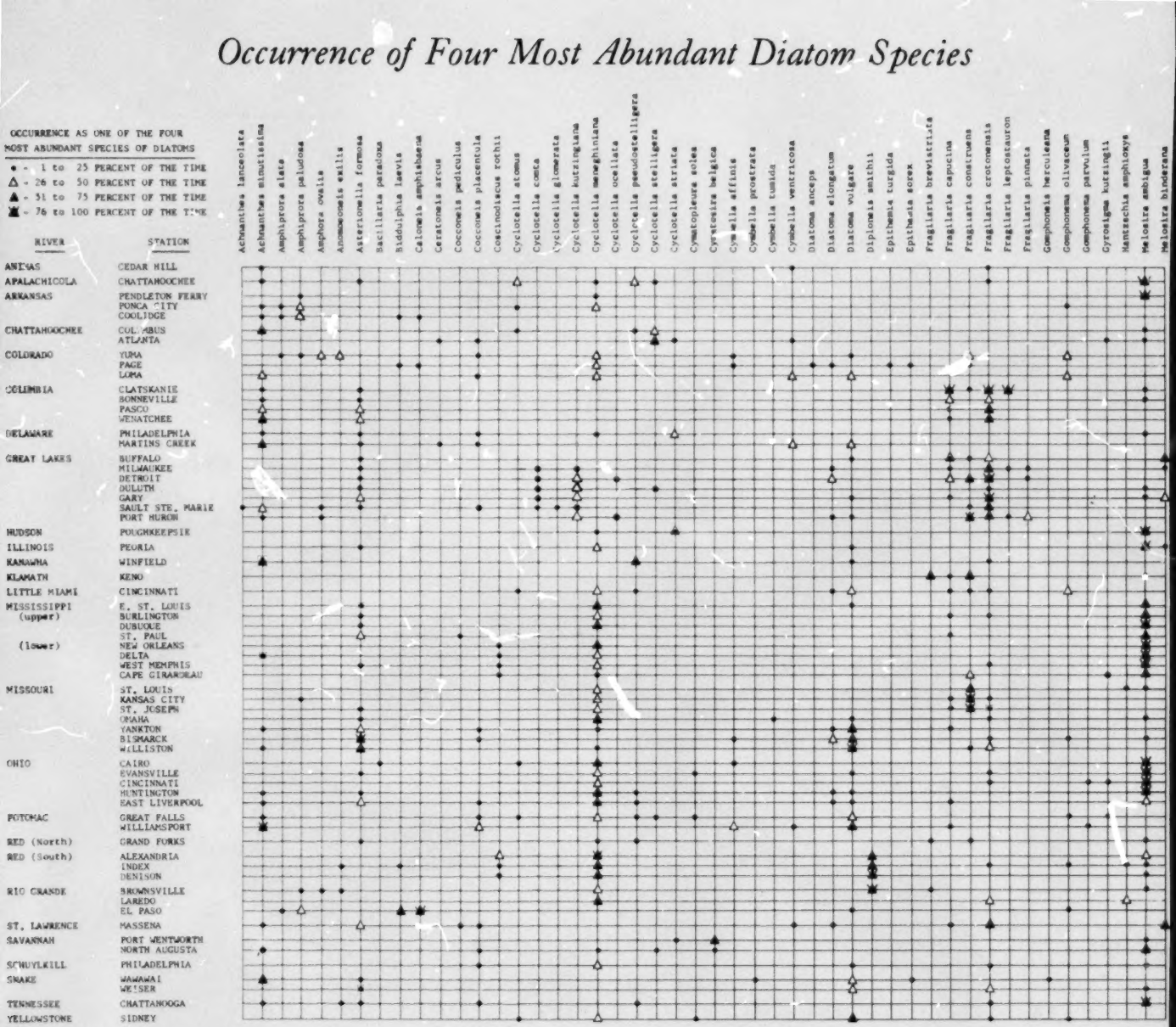
PHS Water Pollution Surveillance System

SAMPLING STATIONS

2 Stations in Alaska not shown
Anchorage and Fairbanks

8-64

Occurrence of Four Most Abundant Diatom Species



Occurrence of Four Most Abundant Diatom Species

OCCURRENCE AS ONE OF THE FOUR MOST ABUNDANT SPECIES OF DIATOMS

- ● - 1 to 25 PERCENT OF THE TIME
- △ - 26 to 50 PERCENT OF THE TIME
- ▲ - 51 to 75 PERCENT OF THE TIME
- ✱ - 76 to 100 PERCENT OF THE TIME

RIVER	STATION
ANIMAS	CEDAR HILL
APALACHICOLA	CHATTAHOOCHEE
ARKANSAS	PENDLETON FERRY PONCA CITY COOLIDGE
CHATTAHOOCHEE	COLUMBUS ATLANTA
COLORADO	YUMA PAGE LOMA
COLUMBIA	CLATSKANIE BONNEVILLE PASCO WENATCHEE
DELAWARE	PHILADELPHIA MARTINS CREEK
GREAT LAKES	BUFFALO MILWAUKEE DETROIT DULUTH GARY SAULT STE. MARIE PORT HURON
HUDSON	POUGHKEEPSIE
ILLINOIS	PEORIA
KANAWHA	WINFIELD
KLAMATH	KENO
LITTLE MIAMI	CINCINNATI
MISSISSIPPI (upper)	E. ST. LOUIS BURLINGTON DUBUQUE ST. PAUL
(lower)	NEW ORLEANS DELTA WEST MEMPHIS CAPE GIRARDEAU
MISSOURI	ST. LOUIS KANSAS CITY ST. JOSEPH OMAHA YANKTON BISMARCK WILLISTON
OHIO	CAIRO EVANSVILLE CINCINNATI HUNTINGTON EAST LIVERPOOL
POTOMAC	GREAT FALLS WILLIAMSPORT
RED (North)	GRAND FORKS
RED (South)	ALEXANDRIA INDEX DENISON
RIO GRANDE	BROWNSVILLE LAREDO EL PASO
ST. LAWRENCE	MASSENA
SAVANNAH	PORT WENTWORTH NORTH AUGUSTA
SCHUYLKILL	PHILADELPHIA
SNAKE	HAHAWAI WEISER
TENNESSEE	CHATTANOOGA
YELLOWSTONE	SIDNEY